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(54) Title: ANTENNA ARRANGEMENT

(57) Abstract: The present invention relates to an antenna arrangement (10) mountable on a carrier (20) inside a communications device and of the type that comprises an antenna element (11) arranged in first plane spaced apart from a ground element (12) arranged in a second plane and at least one feeding connector element (14). The carrier is arranged in a third plane between said first and second planes.

**TITLE****ANTENNA ARRANGEMENT****5 TECHNICAL FIELD OF THE INVENTION**

The present invention relates to a novel antenna arrangement, and a method of manufacturing and mounting such an antenna, which comprises mainly an antenna element distanced from a ground plane.

10

**BACKGROUND OF THE INVENTION**

The wireless forms of communications have become a standard way of communication.

There are many types of means for conducting a wireless communication, such as cordless

15 telephones, lap top computers with wireless modems, satellite and cellular telephones. The communication device, i.e. the mobile handsets rapidly become smaller and lighter and the globalisation demand, multiple communication functions and standards being combined into a single unit, e.g. for communicates in multiple frequency bands. There are a variety of different radiotelephone systems in use today. These include different analogue or digital

20 CDMA (Code Division Multiple Access) and TDMA (Time Division Multiple Access) based systems like GSM (Global System for Mobile telecommunication), AMPS (Advanced Mobile Phone System), DAMPS (Digital Advanced Mobile Phone System), PCS (Personal Communication Services), DCS (Digital Communication System), PCN (Personal Communication Networks ), PDC 800 and 1500 and different cordless telephone systems.

25

Different systems operate in different frequency bands, thus requiring different antennas for maximum efficiency.

Over the past years, since the first PIFA (Planar Inverted-F Antenna) was disclosed, there  
30 have been several types of microstrip antennas with both a feed and a ground connection. Several methods of unique feeding or loading arrangements of the antenna (or combinations

of both) have been disclosed.

Through PIFAs and other ground plane dependent antennas, it is possible to reduce the size of the communications device. These types of antennas are usually arranged on one side of  
5 PCB carrying the electronics of the communications device.

Antennas that are attached to one end of PCB are known, e.g., through Japanese Patent Publication No. 11-355304, which discloses deformed inverted F antenna in which the radiating antenna element is formed of a metallic part and a support body. The metallic part  
10 is formed of a metallic board and a feeding point and a ground contact point are formed at the end parts of the metallic part. The support body is formed of an insulator or a dielectric and holds the metallic part accurately in prescribed form. The metallic part is fixed to the support body to form them into one body. A slit whose thickness is similar to or slightly thicker than that the circuit board is installed in the support body. The antenna element is  
15 fixed to the circuit board by inserting the circuit board into the slit. The feeding point and the ground contact point are connected to the feeder terminal and ground terminal of the circuit board to constitute the objective. This antenna arrangement differs from the present invention in that the ground plane is placed on the PCB onto which it is attached. Thus, a ground plane must be arranged on the PCB in some way, e.g. etching, and the radiator must  
20 have sufficient length to interact with the ground plane. Thus, the antenna provided in this way is more complicated.

#### SUMMARY OF THE INVENTION

25 The main object of the present invention is to provide an antenna arrangement, which is easy to design, manufacture and/or mount in a communication device and which contributes to the reduction of the size of the communications device, specially its thickness.

Another object of the present invention is to provide an antenna arrangement, which is  
30 flexible, i.e. it can easily be rearranged for different demands.

One advantage of the invention is that the antenna position is independent of the placement of the circuit board.

For these reasons the antenna arrangement mountable on a carrier and of the type that  
5 comprises an antenna element arranged in first plane spaced apart from a ground element  
arranged in a second plane and at least one feeding connector element is characterised by the  
fact that the carrier is arranged in a third plane between said first and second planes.

In one embodiment, said carrier is inserted between said antenna element and ground  
10 element, thus allowing easy change of antenna regardless of ground plane's position as it is  
part of the antenna package.

Preferably, when the antenna is mounted on said carrier, said antenna element and ground  
element have substantially same distance to said carrier.

15 The carrier can be a printed circuit board carrying electrical circuitry of the communications  
device.

The antenna arrangement further includes a distance element having a first surface and a  
20 second surface for receiving said antenna element and ground element, respectively, and a  
recess in substantially same distance from said antenna element and ground element. The  
carrier is provided with a projection insertable in said recess.

Advantageously, each of said ground element and antenna element is provided with a  
25 connector member, substantially resiliently connecting them to a connection point on said  
carrier.

The invention also concerns a method of reducing space required by an antenna arrangement  
comprising an antenna element arranged in a first plane and spaced apart from a ground  
30 element arranged in a second plane and provided with at least one feeding connector element  
on a carrier. The method comprises the steps of mounting said antenna element and ground

element with respect to said carrier so that said carrier is positioned in a third plane between said first and second planes.

The invention also concerns a communication arrangement comprising an internally arranged antenna device connected to a circuit board, comprising an antenna element arranged in a first plane and spaced apart from a ground element arranged in a second plane and provided with at least one feeding connector element. The carrier is situated in a third plane between said first and second planes. Preferably, the communication device is a cellular phone or a Bluetooth-based device.

#### 10 BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be further described in a non-limiting way with reference to the accompanying drawings, in which:

- 15 Fig. 1 is a schematic illustration, in perspective, of one preferred embodiment of the invention,
- Fig. 2 illustrates a frontal view of the antenna arrangement according to fig. 1, mounted on a circuit board,
- Fig. 3 is a side view of the embodiment according to fig. 2, and
- 20 Fig. 4 is an enlargement of the encircled section of fig. 3.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

In fig. 1, the antenna according to invention is denoted with 10. The antenna arrangement provided so that it can be mounted at one end of a circuit board 20. The end of circuit board may be any of its edges. The circuit board may be substituted by a carrier, e.g. being part of the communications device chassis or the like.

The antenna is further detailed in figs. 2- 4. Referring to both figs. 1 and 3, the antenna 10 comprises a first conductive layer 11 arranged as the antenna element (radiator), a second conductive layer 12 arranged as a ground plane, a spacer 13, first connector member 14,

second connector member 15 and a connector clasp 16.

The antenna 10 has a PIFA (Planar Inverted F-Antenna) structure. However, the invention concerns all types of antennas of ground plane dependent types. The antenna element 11 and  
5 the ground plane 12 are arranged on each side of the spacer 13, which can be a hollow box-shaped arrangement, and electrically connected together by means of the clasp(s) 16. One or more clasps can be used for holding the parts together. However, other types of attaching means can be used. The plates can also be cut out in one piece and bended to an U-shape, forming the antenna element and the ground plane. The connection can also be provided by  
10 bending a part of one of the plates towards the other one.

Referring now to fig. 4, the spacer 13, which is a substantially prismatic body, has two main faces on which the conductive plates are arranged substantially in parallel. Between said faces, preferably in the middle a recess 133 is arranged substantially parallel to the main  
15 surfaces. The thickness of the recess 133 corresponds basically to the thickness of the board 20. The board 20 is provided with extensions 21 arranged for cooperation with the recess 133 of the spacer 13. Thus, the board attached to the antenna through insertion of the extensions 21 inside the recess 133 becomes substantially centrally arranged with respect to the ground plane and the antenna element. However, the board can be anywhere between the ground  
20 plane and the antenna element. It doesn't need to be inserted between the antenna element and ground plane either, it can be arranged out side the antenna structure.

The attachment between the board and the spacer recess is achieved through friction coupling, but nipping, hitches (not shown) or the like may also be used. In this way the  
25 antenna can be detachably connected to the circuit board, and allow modifications and exchange. It is also possible to arrange extensions on the antenna part connecting to the circuit board. Moreover, when the manufacturing the communications device, the antenna does not need to be connected to the circuit board, and assembly can be carried out later, e.g. depending on the area of use etc.

which are recessed and bended from a corner section of each plate. The connector members can also be arranged on opposite sides of each of the ground plane or antenna element. The spacer 13 is provided with inclined directing surfaces 131 and 132 terminating in the recess 133 for directing and/or supporting the connector members 14 and 15, respectively. The 5 connector members are made slightly longer than the supporting surfaces and provided with bends 141 and 151 for facilitating the insertion of the board 20 between the connector members.

Thus, the connector members resiliently connect each corresponding plate to a connection point 17 and 18 extending on one of extensions 21 of the circuit board 20. In this case the 10 connection points are arranged on opposite sides of the circuit board 20, however, it is also possible to arrange them on an arbitrary and suitable position on the plates. It is also possible to use loose parts or members extending from the board and connecting to the plates.

15 The antenna arrangement according to the present invention can be used in any suitable communications device, such as cellular phones, bluetooth devices etc.

20 The invention is not limited the shown embodiments but can be varied in number of ways without departing from the scope of the appended claims and the arrangement and the method can be implemented in various ways depending on application, functional units, needs and requirements etc. The form and size of the plates, for example, can vary for obtaining the needed characteristics. Moreover, the plates can be provided with slits acting as capacitive and/or inductive loads, e.g. for arranging the antenna as multi-band antenna.

**CLAIMS**

1. On a carrier (20) inside a communications device mountable antenna arrangement (10) of the type that comprises a radiating antenna element (11) arranged in a first plane spaced apart from a ground plane (12) arranged in a second plane and at least one feeding connector element (14),  
*characterized in*  
that said carrier is arranged in a third plane between said first and second planes.
- 10 2. The arrangement of claim 1,  
*characterized in*  
that said carrier is inserted between said antenna element and ground element.
- 15 3. The arrangement of claim 1 or 2,  
*characterized in*  
that said third plane has substantially same distance to said first and second planes.
- 20 4. The arrangement of claims 1 - 3,  
*characterized in*  
that said carrier is a printed circuit board carrying electrical circuitry of the communications device.
- 25 5. The arrangement of claim 1,  
*characterized in*  
that it further includes a distance element (13) having a first surface and a second surface for receiving said antenna element (11) and ground element (12), respectively, and a recess in substantially same distance from said antenna element (11) and ground element (12).
- 30 6. The arrangement of claim 5,  
*characterized in*  
that said carrier is provided with a projection (21) insertable in said recess.

7. The arrangement according to any of preceding claims,

*characterized in*

that each of said ground element and antenna element is provided with a connector member,

5 substantially resiliently connecting them to a connection point on said carrier.

8. A method of reducing space required by an antenna arrangement comprising an antenna element (11) arranged in a first plane and spaced apart from a ground element (12) arranged in a second plane and provided with at least one feeding connector element (13) on a carrier

10 (20),

*characterized b,*

mounting said antenna element (11) and ground element (12) with respect to said carrier so that said carrier is positioned in a third plane between said first and second planes.

15 9. A communication arrangement comprising an internally arranged antenna device (10) connected to a circuit board (20), comprising an antenna element (11) arranged in a first plane and spaced apart from a ground element (12) arranged in a second plane and provided with at least one feeding connector element (13),

*characterized in*

20 that said carrier is situated in a third plane between said first and second planes.

10. The communication arrangement of claim 9,

*characterized in*

that it is a cellular phone.

25

11. The communication arrangement of claim 9,

*characterized in*

that it is a Bluetooth-based device.

30

**AMENDED CLAIMS**

[received by the International Bureau on 29 October 2001 (29.10.01);  
original claims 1-11 replaced by new claims 1-10 (2 pages)]

1. On a carrier (20) inside a communications device mountable antenna arrangement (10) of  
the type that comprises a radiating antenna element (11) arranged in a first plane spaced apart  
from a ground plane (12) arranged in a second plane and at least one feeding connector  
element (14),  
*characterized in*  
that said carrier is at least partly inserted between said first and second planes in a third plane.  
10
2. The arrangement of claim 1,  
*characterized in*  
that said third plane has substantially same distance to said first and second planes.
- 15 3. The arrangement of claim 1 or 2,  
*characterized in*  
that said carrier is a printed circuit board carrying electrical circuitry of the communications  
device.
- 20 4. The arrangement of claim 1,  
*characterized in*  
that it further includes a distance element (13) having a first surface and a second surface for  
receiving said antenna element (11) and ground element (12), respectively, and a recess in  
substantially same distance from said antenna element (11) and ground element (12).  
25
5. The arrangement of claim 4,  
*characterized in*  
that said carrier is provided with a projection (21) insertable in said recess.
- 30 6. The arrangement according to any of preceding claims,  
*characterized in*  
that each of said ground element and antenna element is provided with a connector member,  
substantially resiliently connecting them to a connection point on said carrier.

7. A method of reducing space required by an antenna arrangement comprising an antenna element (11) arranged in a first plane and spaced apart from a ground element (12) arranged in a second plane and provided with at least one feeding connector element (13) on a carrier (20),

5 *characterized by*

mounting said antenna element (11) and ground element (12) with respect to said carrier so that said carrier is positioned and inserted at least partly in a third plane between said first and second planes.

10 8. A communication arrangement comprising an internally arranged antenna device (10) connected to a circuit board (20), comprising an antenna element (11) arranged in a first plane and spaced apart from a ground element (12) arranged in a second plane and provided with at least one feeding connector element (13),

*characterized in*

15 that said carrier is inserted at least partly in a third plane between said first and second planes.

9. The communication arrangement of claim 8,

*characterized in*

that it is a cellular phone.

20

10. The communication arrangement of claim 8,

*characterized in*

that it is a Bluetooth-based device.

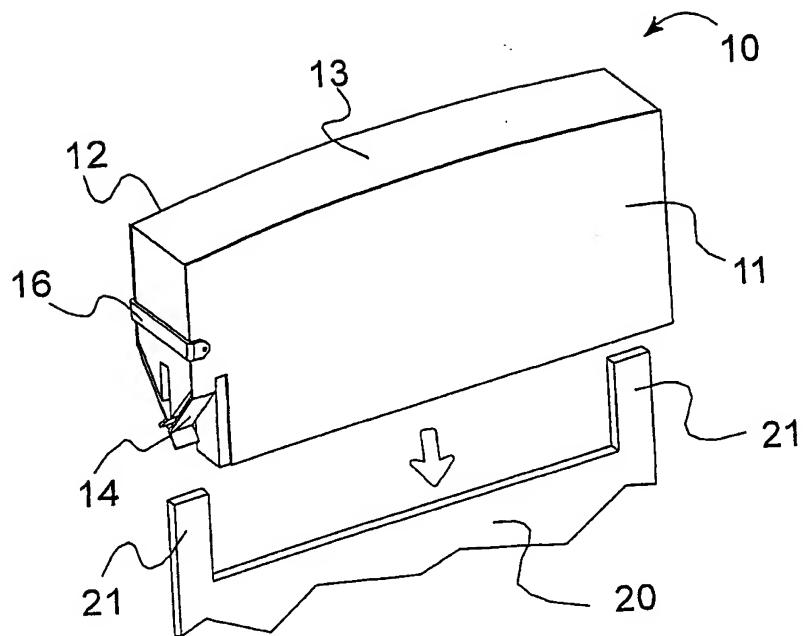


Fig. 1

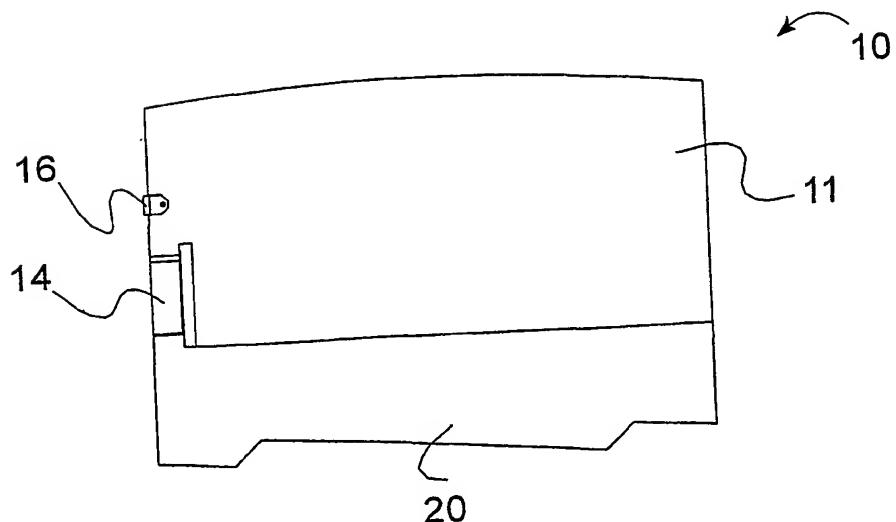


Fig. 2

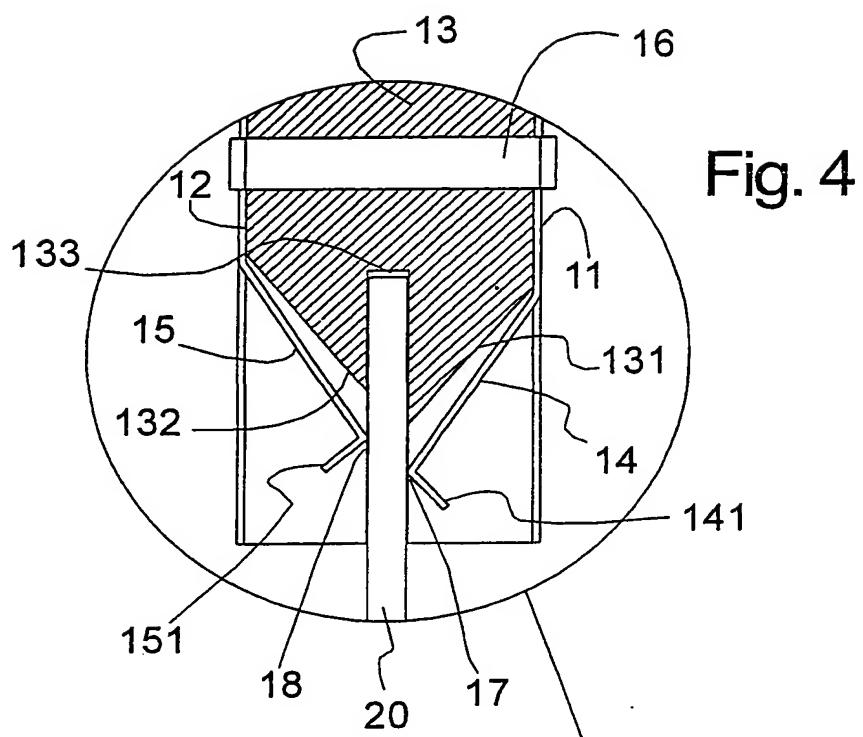


Fig. 4

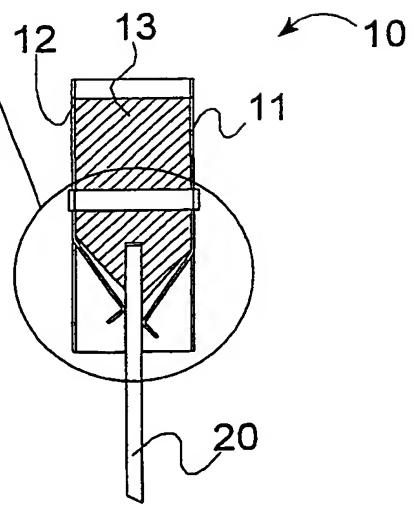


Fig. 3

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 01/01132

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24, H01Q 1/38  
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## EPO-INTERNAL, WPI-DATA

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5874920 A (T. ARAKI ET AL.), 23 February 1999 (23.02.99), column 3, line 55 - line 61 --	1,8-11
A	Patent Abstracts of Japan, abstract of JP 11-355034 A (NEC CORP), 24 December 1999 (24.12.99) --	1-11
A	Patent Abstracts of Japan, abstract of JP 6-244755 A (FUJITSU LTD), 2 Sept 1994 (02.09.94) --	1-11
A	DE 29922053 U1 (NOKIA MOBILE PHONES LTD.), 23 March 2000 (23.03.00), figures 1-9, abstract --	1-11

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report  
29-08-2001

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/01132

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2276274 A (SEKO EPSON CORPORATION (INCORPORATED IN JAPAN)), 21 Sept 1994 (21.09.94), figure 36 --	1-4,8-11
A	EP 0892459 A1 (NOKIA MOBILE PHONES LTD.), 20 January 1999 (20.01.99), column 8, line 33 - line 43, figure 8 -- -----	7

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/08/01

International application No.  
PCT/SE 01/01132

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